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Historical trends in the incidence of strandings of sperm whales (*Physeter macrocephalus*) on North Sea coasts: An association with positive temperature anomalies

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Abstract

Information on the migration patterns of sperm whales (*Physeter macrocephalus*) in the North Atlantic is preserved in historical strandin records, particularly for the North Sea, where sperm whale strandings have been documented since the 16th century, reflecting general pub interest in large whales ashore. Most strandings in this area occur during or following the southward migration from the feeding grounds, wh some animals enter the North Sea (in which they are thought to have difficulty navigating) instead of following their usual route through deep wa to the west of the British Isles. There was much speculation about the causes of the high incidence of strandings on North Sea coasts in the 199 among which a recently published analysis of long-term trends in strandings indicated an effect of sunspot cycle length. We show that long-te interannual variation in the incidence of sperm whale strandings on North Sea coasts is related to positive temperature anomalies: the inciden of strandings was higher in warmer periods. The effect of temperature anomalies explains between 8 and 9% of variation in the strandings seri Inclusion of sunspot cycle length as an additional predictor did not significantly improve this model. It is suggested that this link with positi temperature anomalies may reflect changes in the distribution of the sperm whales' main squid prey.

Keywords: Sperm whale; *Physeter macrocephalus*; Strandings; North Sea; Temperature anomalies; Sunspot cycles

1. Introduction

Climate is a dominating factor in the Earth's ecosystems and there is compelling evidence that many organisms are affected by climatic variation. This particularly applies to migratory species that travel over large distances, being subject to a wide range of environmental influences and relying on a great variety of natural resources (e.g. Robinson et al., 2005). In the marine environment, a recent increase in temperature has been associated with northward shifts in fish distribution (Perry et al., 2005), earlier migration of squid (Sims et al., 2001) and earlier egg-laying in turtles (Weishampel et al., 2004). Shifts in prey distribution may in turn affect marine mammals (Learmonth et al., 2006). Temporal patterns in cetacean strandings m reflect large-scale climatic events, e.g. due to shifts in distrib tion related to climate-driven changes in productivity (Evans al., 2005). For example, cetaceans may follow upwelling fron and run a greater risk of becoming stranded if the front is clo to the shore (Walker et al., 2005).

Sperm whales (*Physeter macrocephalus*) show a strong se ual dimorphism and a high degree of geographical segregati between sexes. Pods of females with calves stay on or ne the breeding grounds throughout the year, roughly betwe 40–45°N and 40–45°S (Rice, 1989; Whitehead, 2003). Mal on the contrary, undertake long migrations between low-latitu breeding areas and high-latitude feeding grounds. In the Nort ern Hemisphere, "bachelor" groups comprising male sper whales upwards of 15–21 years old, as well as old bulls n taking part in reproduction, generally leave warm waters at t beginning of summer and migrate to feeding grounds that m

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